Status of CRESST and Cryogenic Future of Direct WIMP Search

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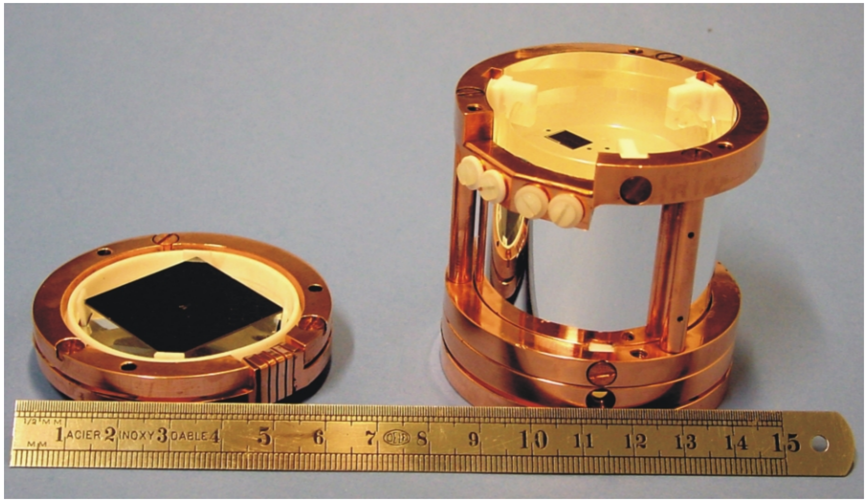
Overview

- CRESST
  - Technique
  - Quenching factors
  - Status: Results & Upgrade
- Future
  - SuperCDMS
  - EURECA

CRESST

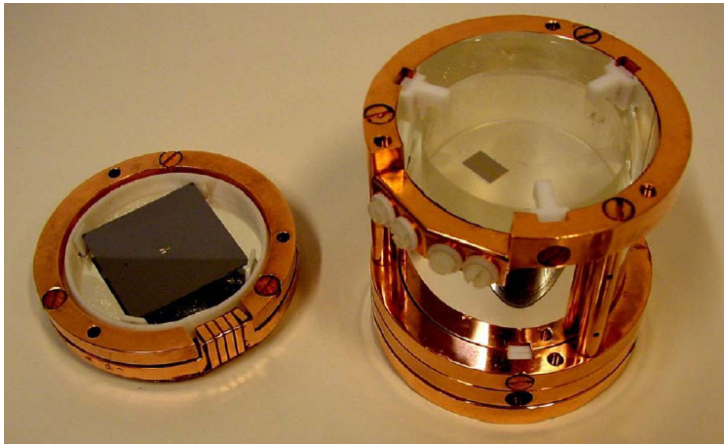
Cryogenic
Rare
Event
Search with
Superconducting
Thermometers

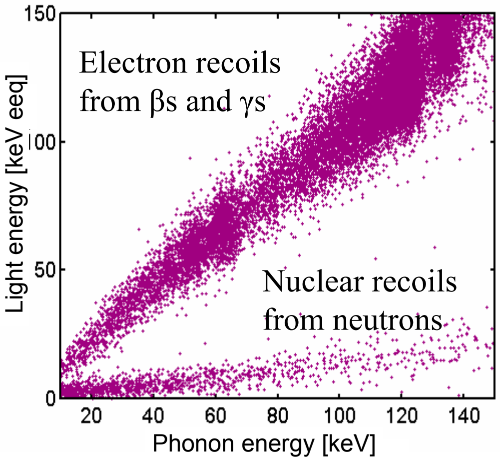
Max-Planck-Institut für Physik
Technische Universität München
University of Oxford
Universität Tübingen
Laboratori Nazionali del Gran Sasso



CRESST – Technique

- WIMP Target: scintillating $CaWO_4$ single crystals
- Cryogenic detectors, thermal readout: TES
- Simultaneous measurement of thermal signal and scintillation light for background discrimination
- Light detection with separate cryogenic detector; reflective housing for efficient light collection



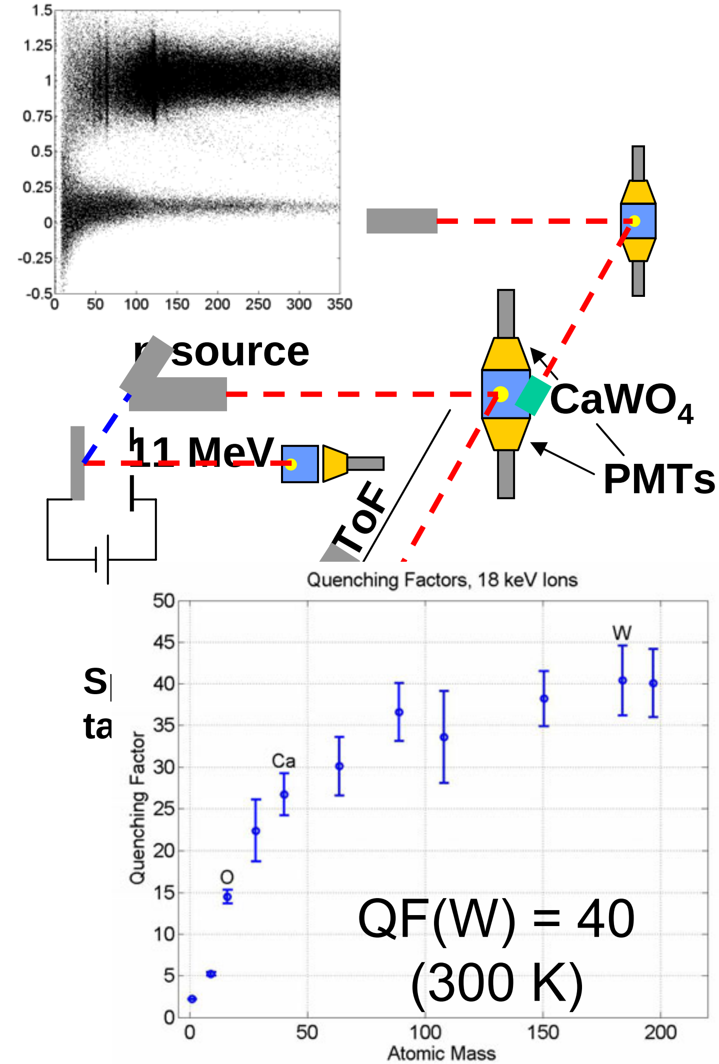


CRESST – Technique

CRESST – Quenching

- Different light yield for electron and nuclear recoils (Quenching)
- Three types of nuclei (O, Ca, W), need detailed investigation (WIMPs: mainly W-recoils !!)
- Three different approaches:
  - Standard neutron source
  - Neutron scattering experiment
  - Ion irradiation

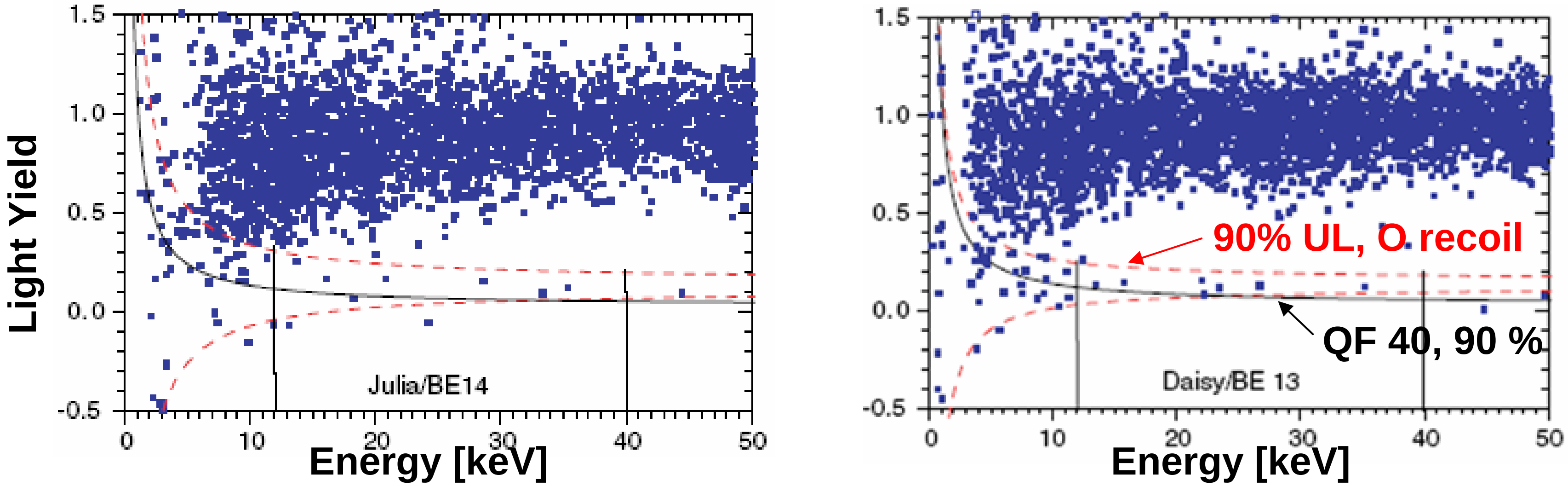
All three show less light for heavier nuclei!



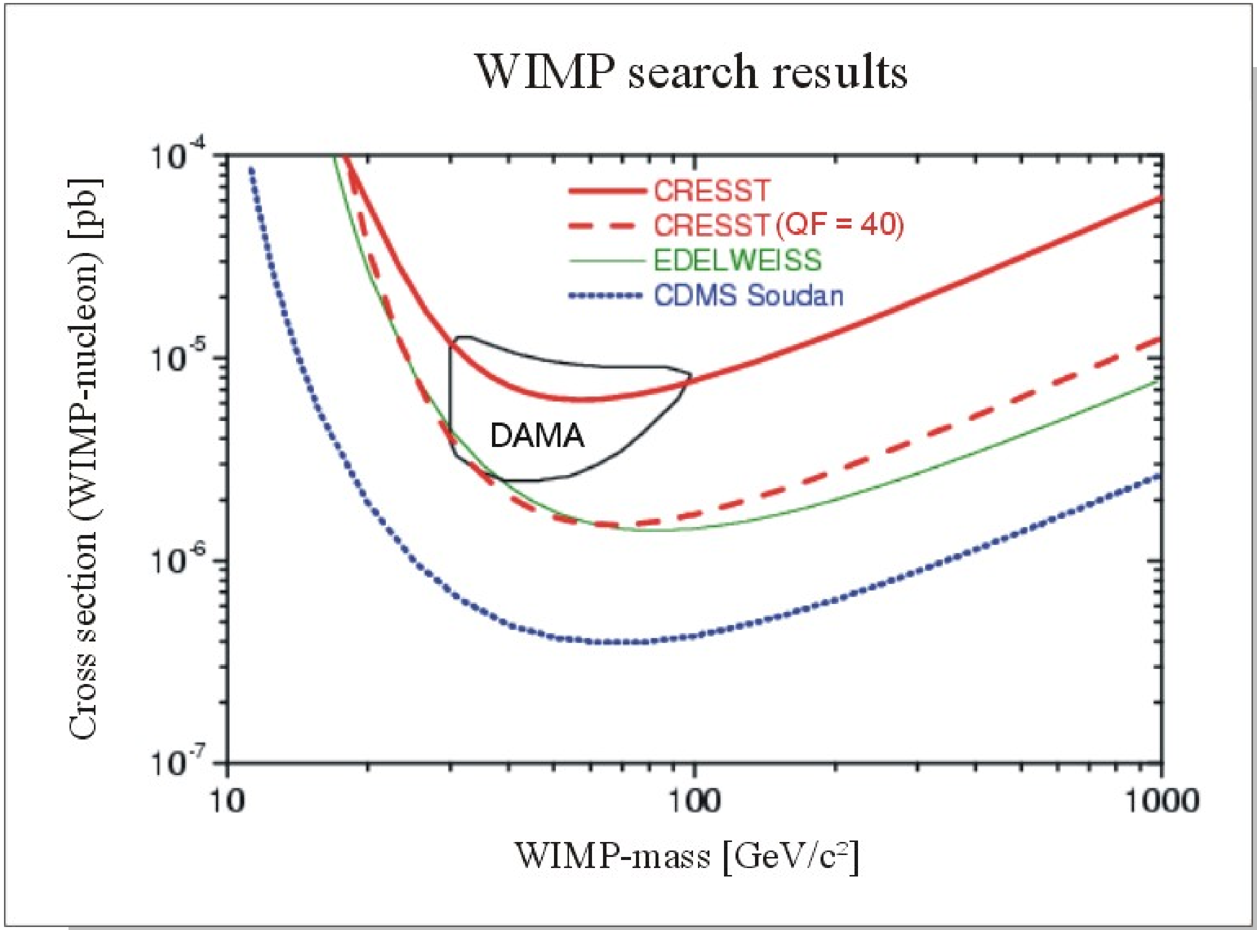
CRESST – Status: Results

- Spring 2004: ~ 2 months run, total exposure ~ 20 kg d
- 2 detectors (one with very good light resolution)
- No neutron shield, no muon veto

⇒ Analysis threshold: 12 keV, WIMPs: < 40 keV recoil (W)
⇒ Nuclear recoils: 16 events or (0.9 ± 0.2)/ kg d
⇒ Good resolution in Daisy/BE 13: 0 evts with high QF



CRESST – Status: Results

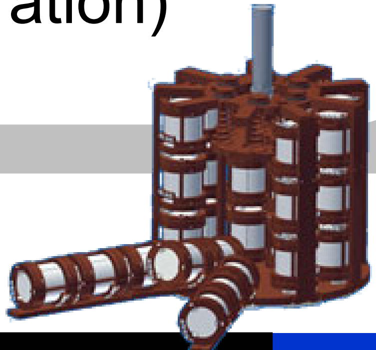


Result robust w.r.t. changes of analysis threshold and QF !

CRESST – Status: Upgrade

Upgrading since April 2004

- Neutron moderator, 11 t PE installation ready
- Muon veto installed
- 66 channel SQUID system for 33 detector modules (10 kg) installed
- Detector integration system being produced
- Some more work on electronics, DAQ (testing, integration)



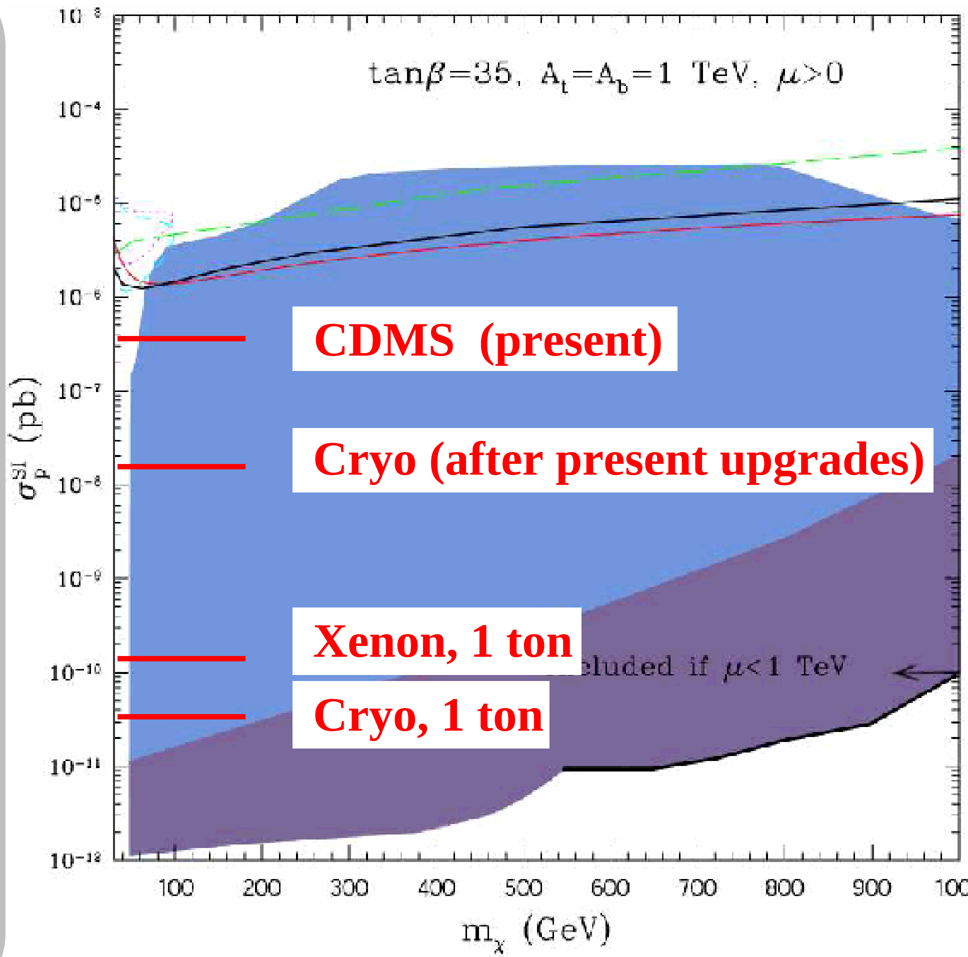
Shielded cryostat

PE neutron moderator

Plastic scintill. μ-veto

Future

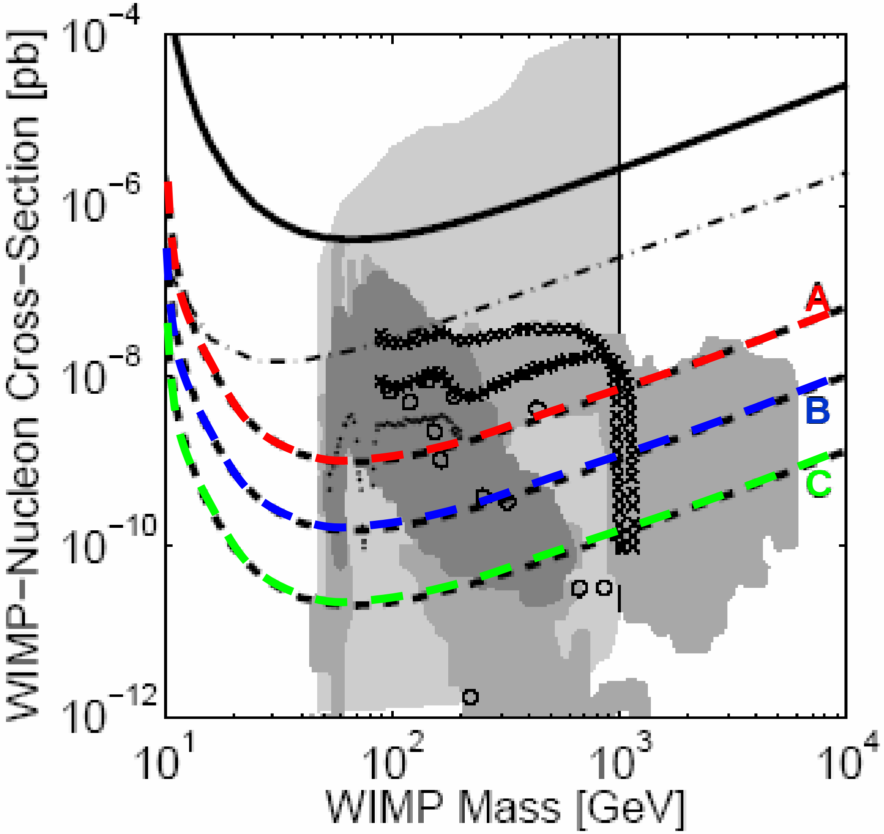
- SUSY prediction: $\sigma > 10^{-12}$ pb
- Present status: 2×10^{-7} pb
- Cryos: presently upgrading to sensitivity ~ 10^{-8} pb
- Proposals for next generation experiments (~ 1 ton target):
  - liq. Xe: ZEPLIN (UK), XENON (US)
  - cryo: SuperCDMS (US) EURECA (EU)
- no signal / $\sigma < 10^{-11}$ pb: SUSY (almost) excluded ???
- $\sigma \sim 10^{-7}$ pb: astro/particle physics with next gen. exp.



Future – SuperCDMS

- Long term goal: 10^{-11} pb
- Target: up to ~ 1 ton Ge
- Strategy: several phases
  - Continue at Soudan, develop/test/run new detectors
  - Move to SNOLab, 27 kg (A)
  - Increase mass: 145 kg (B)
  - Final phase: 1100 kg (C)
- Zero BG:
  - Improve detector discr.
  - Reduce contamination
  - Improve analysis

SuperCDMS collaboration
≈ CDMS collaboration



Future – EURECA

European
Underground
Rare
Event
Calorimeter
Array

CRESST & EDELWEISS + new groups:

University of Oxford
MPI für Physik, Munich
Technische Universität München
Universität Tübingen
Universität Karlsruhe
Forschungszentrum Karlsruhe
CEA/DAPNIA Saclay
CEA/DRECAM Saclay
CNRS/CRTBT Grenoble
CNRS/CSNSM Orsay
CNRS/IPNL Lyon
CNRS/IAP Paris
CERN

- Goal 10^{-10} – 10^{-11} pb
- Target: several 100 kg, different materials (A-dependence of spectrum / spin dependence)
- CRESST & EDELWEISS as R&D

Future – EURECA

Tasks:

- Detector development (discrimination, module size, new materials, mass production)
- Low radioactivity (material selection, processing, handling)
- Neutron background (μ-veto, shielding, MC simulations)
- Cryogenics (cold volume, cooling power, radiopurity, duty cycle)
- Electronics, readout, cabling
- Underground site issues (shielding, rock activity, space, infrastructure, safety)

Future – EURECA

ILIAS:
Integrated Large Infrastructure for Astroparticle Science
(EU Integrated Infrastructure Initiative)

- Provides platform for general discussion
- Covers some tasks partly in different substructures:
  - Neutron background MC simulations (e.g. N3, BSNS)
  - Low radioactivity (JRA1)
  - Underground site issues (N2)

Future – EURECA

First steps:

- Run next phase of EDELWEISS and CRESST
- Demonstrate technology on several kg scale
- Start R&D (cryogenics, detectors, electronics, simulations)
- Find WIMPs